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From science and environmental education to civic science

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The challenges facing the world now seem very different to those we faced 50 years ago. As a result we need radically different forms of education and engagement which require a convergence of science education and environmental education as well as more action-oriented participatory pedagogies. Back in 1967, in the first *JBE* editorial, Otto Lowenstein identified one of the key roles of biological education as helping to equip humanity 'for physical survival by means of entirely new methods of food production and through biologically sound and safe population control' (Lowenstein, 1967, i). The challenges of the 1960s were seen, to use Fox and Gibson's (2013) typology, as at best simple and at worst complex. Today's challenges, including climate change, biodiversity loss and food security, are increasingly being seen as 'wicked' – impossible to fully comprehend, insoluble and chaotic. As Ron Barnett puts it, in asking 'What is it to learn for an unknown future?': 'The unknown-ness derives from the complexity of multiplying descriptions of the world such that we cannot even describe the challenges that face us with any assuredness' (Barnett, 2012, 65).

Addressing wicked problems requires a completely different mind-set to that prevalent in the 1960s. Harold Wilson, who was prime minister when *JBE* was launched, had argued earlier in the decade for a 'scientific revolution' – to move Britain out of the post-war mindset and in to a relatively unknown but probably better future. Wilson signaled the scale of the requisite changes noting: 'that revolution cannot become a reality unless we are prepared to make far-reaching changes in economic and social attitudes which permeate our whole system of society' (Labour Party, 1963, 7).

Many of the wicked problems facing society involve the environment, conservation and sustainability. Back in the 1960s, a rise in public awareness of the environment began with the publication of Rachel Carson's 'Silent spring' in 1962. In 1967, the sight of the *Torrey Canyon* oil tanker leaking over 30m gallons of crude oil off the coast of Cornwall leading to the death of over 15,000 seabirds brought home to the UK public the fact that the benefits of an increasingly technology driven lifestyle had concomitant social, economic and environmental risks.

While the environment featured increasingly in the school curriculum, science teachers, in general, rarely acknowledged that science was not value free. Wals et al. (2014) noted that whereas science education tended to focus primarily on teaching knowledge and skills, environmental education, which struggled for curriculum time, stressed a wide variety of disciplinary knowledge as well as the incorporation of values and changing behaviors. Indeed the relationship between the two curriculum areas was characterised as 'distant, competitive, predator-prey and host-parasite' (Gough, 2002, 1201). The rise of wicked problems, argue Wals et al., demands greater convergence between science and environmental education. In terms of what such a convergence might look Wals et al. argue for 'collaborative research efforts among scientists, educators, and the public, linking science and society with place and identity, through more effective

processes of public engagement and learning that can result in meaningful socioecological outcomes' (2014, 584).

The collaborative research efforts would require new approaches to public participation in scientific research (PPSR) (often referred to as 'citizen science') which, traditionally, has been driven by the needs of scientists rather than by the needs of society. Bonney et al. have noted that as long ago as 1880, members of the public took part in large-scale data collection: lighthouse keepers used to collect data about bird strikes. National and international bird surveys are common and can be dated back to the National Audubon Society's Christmas Bird Count which was launched in 1900. Bonney et al. argue that 'PPSR projects have the potential to yield major impacts, particularly Collaborative and Co-created projects, which engage participants in project design and data interpretation to a significant degree' (Bonney et al., 2009, 12).

Wals et al. argue for a more participatory approach to citizen science project and advocate the use of information technologies: 'The data gathered and shared [...] can provide useful input to environmental scientists while simultaneously empowering citizens to engage in ongoing debates about local and global sustainability issues and what needs to be done to address them' (2014, 584). However, shifting from science and policy-driven citizen science to fully participatory civic science is not without its challenges. Wals et al. (in press) argue that 'both the composition of the citizen participants as well as the nature and processes of the science must also undergo a paradigm shift.' Any environmental issue is likely to have multiple stakeholders and they all need to be involved in the process of co-learning and knowledge building.

Addressing wicked problems involves using knowledge which is both uncertain and contested. Local knowledge of conservation issues may well conflict with more generalised knowledge developed in other contexts. Negotiating ways through this complexity requires skilled facilitation, trust and time. As Wals et al. argue: 'an important part of this process is treating emerging goals and knowledge as tentative and subject to revision based on ongoing critical and collaborative dialogue, inquiry and action' (in press).

Educating people for such processes requires paying attention to issues of place and identity. Whole-school approaches to sustainability, whether they be eco-schools, green schools or forest schools, involve developing a wider range of learning than has traditionally been the case: inquiry-based, disciplinary, and social learning supported by new technologies encourage more authentic engagement with science and the environment. School grounds may play a more significant role in local communities, becoming places where interactions between food, health, ecology the other sciences become common-place.

Looking back to the 1960s, Harold Wilson's 'far-reaching changes in economic and social attitudes which permeate our whole system of society' have not yet emerged. Both science and environmental education can play a part in facilitating change and they must if we are to address global issues such as biodiversity loss, poverty and climate change.

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